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Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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Method and apparatus for generating look-up table data in the video picture field

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METHOD AND APPARATUS FOR GENERATING LOOK-UP TABLE DATA IN THE VIDEO PICTURE FIELD

The present invention relates to a method for generating look-up table data in the video picture field. It also relates to a circuit for implementing said method.

The present invention is particularly useful in the field of plasma display panels (PDPs) or other display devices wherein each video level is represented by a combination of bits according to a specific coding. In this case, when the algorithms used to improve picture quality are based on data stored in memories such as look-up tables (LUTs), the size of such tables may be quite huge.

BACKGROUND OF THE INVENTION

To understand the problem, the present invention will be described in relation with PDP but may be applicable to other types of display or other apparatus processing video data and requiring memories with huge size.

To improve picture quality in PDPs, a lot of algorithms have been developed, using data stored in look-up tables. For example, in EP patent application 1 353 314, is described a method for improving grey scale fidelity portrayal based on a modification of the coding approach for each average power level (APL) that occurs at each frame. It is based on a Metacode concept wherein the subfield code based on subfield weights is replaced by a metacode based on subfield actual luminance. More specifically, for a given peak white level, the sustain pulses are distributed among the sub-fields, the number of pulses of a sub-field corresponding to its weighting. Then, the sub-field codes are mapped to luminance codes, which are re-ordered in a definite order. Moreover, the video levels are mapped to the available luminance codes and processed to achieve intermediate levels of luminance. Then, the luminance codes are mapped to the output sub-field codes. In this case, look-up tables are used at least for mapping the video levels to the luminance codes and for mapping the luminance codes to the output sub-

field codes. These look-up tables, which contain, for example, luminance codes to be loaded for each new APL value, are stored in an external memory. These tables, called metacode look-up tables, are quite huge.

Figure 1 is a standard implementation circuit of a metacode coding unit as described in EP patent application 1 353 314. This unit comprises a first memory 100 comprising 1024 x 12 bits for handling 10 bits of input video resolution. A first metacode look up table is stored in this memory and is used for mapping the video levels to available luminance codes. It can include or not a degamma function. A new metacode look up table is loaded in the memory 100 each time the APL value changes. At the output of the memory 100, 12 bits video signal is obtained. The available 12-bits correspond to 8-bits integer resolution and 4-bits fractional resolution. Then, the 12-bits of video signal YA [11-0] are forwarded to a dithering circuit 110. In this circuit 110, the 4-bits of fractional resolution are added with the 4-bits of dithering and then truncated.

The video signal YB[7,0] from the circuit 110 is then forwarded to a second memory 120 comprising 256 x 16 bits. A second look-up table is stored in the memory 120 and is used to implement the transcoding step that is the step of mapping luminance codes to the output subfield codes.

As mentioned previously, the memory 100 needs to be updated with a new metacode look-up table each time the APL value changes. A look-up table is provided for each APL value. These look-up tables are stored in an external memory 130, e.g. a FLASH memory, EEPROM,... A metacode look-up table defines, for each video level and for a given APL value, a 12 bit code representative of the luminance code to be generated for achieving the video level. In case of a 10 bit APL value, an external memory with a size of 1024x1024x12 = 12 Mbit is needed.

Moreover, if different metacode look-up tables are needed for each color, it increases the total size of the memory 130 to 36Mbit. Furthermore, since the metacode look-up tables are different for each display mode used in the Plasma Display Panel, e.g. 60Hz, 50Hz, 75Hz... it further increases the needs in terms of external memory : 108Mbit for 3 modes.

Therefore, one major problem of the implementation circuit of Figure 1 is the large size of the external memory 130.

It is the purpose of the present invention to propose a way to reduce the amount of data needed for implementing said metacode method by using a low number of metacode look-up tables and by extrapolating the other ones.

In a general manner, the invention relates to a method for generating a look-up table data for a input video data and a given value of a parameter among N different values.

The method of the invention can be used for generating a metacode look-up table data for a given value of average power level.

It can also be used for generating other look-up table data in the video picture field.

SUMMARY OF THE INVENTION

So, the invention proposes a method for generating a look-up table data for an input video data and for a given value of a parameter among N different values, characterized in that said look-up table data is generated from two look-up tables defined for the two bound values of said parameter and an extrapolation coefficient, said look-up tables comprising an output data for each possible input video data.

If the look-up table data can be approximated by a piecewise linear function of a variable depending on the given value, the method of the invention comprises the following steps

- dividing the set of N values into P subsets of consecutive values, each piece of the piecewise linear function being in a different subset;
- defining a look-up table for the two bound values of each subset i, called primary look-up table and secondary look-up table respectively, each of said primary and secondary look-up tables comprising an output data for each possible input video data (YI),

- defining, for each subset i, a delta look-up table corresponding to the difference between the secondary look-up table and the primary look-up table related to the subset i,

- defining, for each one of said N values, an extrapolation coefficient in accordance with the value of a variable S for the given value and the values of the variable S for the two bound values of the subset i comprising the given value; and

- computing the look-up table data for said input video data and for the given value in accordance with the extrapolation coefficient defined for the given value and the output data of the primary look-up table and the delta look-up table for said for said input video data.

In the embodiment described here, the generated look-up table data is a Metacode look-up table data, the parameter is an average power level and the variable is a number of sustain pulses corresponding to the given value of the parameter.

The bound level related to the primary look-up table of a subset of average power level values is the highest average power level value of the subset and the bound level related to the secondary look-up table of a subset of average power level values is the lowest average power level value of the subset.

Preferably, the ratio between the value of the variable for one bound value in the subset i and the value of the variable S for the same bound value in the subset i+1 equals to a fixed parameter α. The parameter α is defined as followed $\alpha = \sqrt[N]{\frac{S_{MAX}}{S_{MIN}}}$ where S_{MAX} is the value of the variable S for a peak white image and S_{MIN} is the value of the variable S for a full white image. The extrapolation coefficient is proportional to $\frac{S(VAL)-S(PMTC_i)}{S(SMTC_i)-S(PMTC_i)}$ where $S(PMTC_i)$ is the value of the variable S for the highest bound value of the subset i; $S(SMTC_i)$ is the value of the variable S

for the lowest bound value of the subset i; and S(VAL) is the value of the variable for the given value.

The computed look-up table data equals to the sum of the output data of the primary look-up table for the given value VAL and the output data of the delta look-up table for the input video data and the given value VAL weighted by the extrapolation coefficient for the given value VAL.

The invention concerns also a device for generating a look-up table data for an input video data and for a given value of a parameter among N different values, said output data being approximated by a piecewise linear function of a variable depending on the given value, the set of N values being divided into P subsets of consecutive values, each piece of the piecewise linear function being in a different subset, characterized in that it comprises:

- a first memory for storing, for each subset i, a primary look-up table associated to a bound value of the subset i and comprising an output data for each possible input video data,

- a second memory for storing, for each subset i, a delta look-up table corresponding to the difference between a secondary look-up table and the primary look-up table related to the subset i, the secondary look-up table being associated to the other bound value of the subset i and comprising an output data for each possible input video data,

- a third memory for storing, for each of said N values, an index indicating which primary look-up table in the first memory and which delta look-up table in the second memory have to be used for extrapolation,

- a fourth memory for storing an extrapolation coefficient for each one of said N values, the extrapolation coefficient associated to a given value being defined in accordance with the value of a variable S for said given value and the values of the variable S for the two bound values of the subset i comprising said given value; and

- a computing block for generating a look-up table data for said input video data and for the given value in accordance with the extrapolation

coefficient defined for the given value and the output data of the primary look-up table and the delta look-up table for said input video data.

The above-mentioned method can be implemented in this device.

DRAWINGS

Exemplary embodiments of the invention are illustrated in the drawings and are explained in more detail in the following description.

In the figure :

Figure 1 is a schematic showing an implementation of a prior art method; and

Figure 2 is a schematic showing a possible implementation of the method according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention will be described with reference to the generation of metacode look-up tables for different Average Power Level or APL values.

The goal of the invention is to reduce the number of look-up tables needed. Only some look-up tables will be predefined for some APL values and, for the other APL values, new look-up tables will be extrapolated from these predefined look-up tables.

In the following specification, a metacode LUT, defined for a given APL value, defines for each input video level an output level expressing a luminance code to be used.

According to the invention and as illustrated by Figure 2, four look-up tables with a total size inferior to the size of the memory 130 of Figure 1 and an evaluation block are used to implement the metacode look-up tables for all APL values:

- a first look-up table LUT1 which comprises itself 16 metacode LUTs, called primary metacode LUTs; each primary metacode LUT

comprises metacodes related to a specific APL value, called primary APL value; the primary APL values will be described below in the specification;

- a second look-up table LUT2 which comprises 16 delta LUTs corresponding to the difference between secondary metacode LUTs and said primary metacode LUTs; each secondary metacode LUT comprises metacodes related to a specific APL value, called secondary APL value; the secondary APL values will be described below in the specification;

- a third look-up table LUT3 which comprises, for each APL value, an index indicating which primary metacode LUT in LUT1 and which delta LUT in LUT2 have to be used for the extrapolation,

- a fourth look-up table LUT4 which comprises, for each APL value, the coefficient to be used for the extrapolation, and

- an extrapolation block EXTRAPOL for calculating a LUT.

As mentioned above, each subset of APL values comprises a primary APL value and a secondary APL value. The set of APL values comprises for example 1024 values from 0 to 1023 and is for example divided into 16 subsets of consecutive APL values. The primary APL value is the highest APL value (corresponding to the smallest number of sustain pulses) of the subset and the secondary APL value is the lowest APL value (corresponding to the highest number of sustain pulses) of the subset. A primary metacode LUT is defined for each primary APL value. These primary metacode LUTs are stored in the LUT1. A secondary metacode LUT is defined for each secondary APL value but these secondary metacode LUTs are not stored in the LUT1 or LUT2. They are only used for calculating the delta LUTs stored in LUT2.

The Look-up table LUT3 delivers, for each APL value, a pointer on the primary Metacode LUT which has to be used for generating the Metacode LUT of this APL value. The LUT 3 has a 10-bit input and a 4-bit output for selecting one of the 16 primary metacode LUTs.

The notations used in the specification are the following ones :

- $PMTC_i$ represents the primary metacode LUT related to the subset i of APL values,
- $S(PMTC_i)$ represents the number of sustain pulses for the APL value (primary APL value) corresponding to the primary metacode LUT $PMTC_i$;
- $PMTC_i(V)$ represents the output of the primary metacode LUT $PMTC_i$ for the video level V;
- $SMTC_i$ represents the secondary metacode LUT related to the subset i of APL values,
- $S(SMTC_i)$ represents the number of sustain pulses for the APL value corresponding to the secondary metacode LUT $SMTC_i$;
- $SMTC_i(V)$ represents the output of the secondary metacode LUT $SMTC_i$ for the video level V; and
- S(X) represents of the number of sustain pulses for the APL value X.

Some jumps can appear when switching from one primary metacode LUT to another one. For example, the smallest sub-field code value (1 sustain pulse for example) has a different relative value (which is equal to 1/total amount of sustain pulses) in comparison with the smallest sub-field code value used for another primary metacode LUT) since the total amount of sustain pulses changes from one primary Metacode level to another one (from one APL value to another). The ratio of these two different values (which is equal to the ratio of the two different total amounts of sustain pulses of the two primary metacode LUTs) could create a jump.

In order to have nearly the same visibility of possible jumps when switching from one primary Metacode to another one, these ratios should be equal as follows :

$$\frac{S(PMTC_0)}{S(PMTC_1)}=\frac{S(PMTC_1)}{S(PMTC_2)}=\ldots=\frac{S(PMTC_i)}{S(PMTC_{i+1})}=\ldots=\frac{S(PMTC_{14})}{S(PMTC_{15})}=\alpha$$

This means that the division is made in a logarithmic way. The previous formula means that the 2^{nd}, the 3^{rd}, ... and the 15^{th} subsets of APL values have the same ratio between the number of sustain pulses of their smallest

APL value and their highest value. If this ratio α is also imposed to the first subset, we have

$$\alpha = \frac{S_{MAX}}{S(PMTC_0)} = \frac{S(PMTC_0)}{S(PMTC_1)} = \ldots = \frac{S(PMTC_i)}{S(PMTC_{i+1})} = \ldots = \frac{S(PMTC_{14})}{S(PMTC_{15})}$$

where S_{MAX} is the number of sustain pulses for a peak white (low APL value)

When multiplying all terms together, we find that:

$\alpha^{16} = \frac{S_{MAX}}{S(PMTC_{15})} = \frac{S_{MAX}}{S_{MIN}}$ where S_{MIN} is the number of sustain pulses for a full white image.

So $\alpha = \sqrt[16]{\frac{S_{MAX}}{S_{MIN}}}$ and $S(PMTC_i) = S_{MIN} \times \alpha^{15-i}$

This division in a logarithmic way is only a suggestion in order to have the same visibility of possible jumps when switching from one primary metacode LUT to another one; but it is possible to use a different division of the APL set. For example, it is possible to use a different division in order to have more subsets for the low values of APL, and less for the high values of APL.

In an example given in the annex below, the set of APL values is divided in 16 subsets. The primary APL values (lowest APL value of each subset) are marked in bold characters and the secondary APL values (highest APL value of each subset) are marked in black areas.

This example is given for the following inputs:

- Peak white image: 1100 sustain pulses
- Full white image: 200 sustain pulses.

The parameter α is equal to :

$$\alpha = \sqrt[16]{\frac{S_{MAX}}{S_{MIN}}} = \sqrt[16]{\frac{1100}{200}} \approx 1.1135.$$

The 16 primary APL values, used for the primary Metacode LUTs, are determined as indicated in the annex table. The maximal number of sustain

pulses of the primary metacode LUT $PMTC_i$ is $200 \times \alpha^i$ sustain pulses, with i = 0..15.

The APL values are distributed as follows:

APL values from 0 to 135	→ Subset 15
APL values from 136 to 230	→ Subset 14
APL values from 231 to 318	→ Subset 13
APL values from 319 to 398	→ Subset 12
APL values from 399 to 473	→ Subset 11
APL values from 474 to 540	→ Subset 10
APL values from 541 to 604	→ Subset 9
APL values from 605 to 663	→ Subset 8
APL values from 664 to 716	→ Subset 7
APL values from 717 to 766	→ Subset 6
APL values from 767 to 812	→ Subset 5
APL values from 813 to 856	→ Subset 4
APL values from 857 to 898	→ Subset 3
APL values from 899 to 938	→ Subset 2
APL values from 939 to 978	→ Subset 1
APL values from 979 to 1023	→ Subset 0

As an example, for the subset 15, the primary APL value is 135 and the secondary APL value is 0. The maximal number of sustain pulses for the primary metacode LUT is 988 and for the secondary metacode LUT is 1100. The metacode LUTs related to APL values comprised between 1 and 134 of subset 15 are computed by extrapolation. It is an extrapolation in the sense that it is not an interpolation between two metacode LUTs related to different subsets. These metacode LUTs related to APL values 1...134 can be achieved by an interpolation between the primary metacode LUT related to the APL value 135 and the secondary Metacode LUT related to the APL value 0. The secondary metacode LUT is only used for the extrapolation.

In a preferred embodiment, the extrapolation for the APL values of a subset i is made between the primary metacode LUT $PMTC_i$ and a delta LUT corresponding to the difference between primary metacode LUT $PMTC_i$ and the secondary metacode LUT $SMTC_i$. This difference LUT, noted $LUT2_i$, is stored in the look up table LUT2. The values in the delta LUTs contained in this LUT2 can be positive or negative, but a 8 bit resolution is enough.

The value stored in the delta LUT related to the subset i in the LUT2 and precalculated for a video level V is :

$$LUT2_i(V) = \frac{64 \times (SMTC_i(V) - PMTC_i(V))}{63}$$

The coefficients 64 and 63 are used here for hardware considerations because the coefficient used for the extrapolation is coded on 6 bits and because it is easier to make a division by 64 than by 63 in hardware in the following final extrapolation.

Preferably, for evaluating the look-up table LUT2, more resolution should be used for $PMTC_i(V)$ and $SMTC_i(V)$ than available for the LUT1.

The extrapolation coefficient for an APL value VAL belonging to the subset i, referenced C(VAL), used for the extrapolation is the ratio of the difference between the number of sustain pulses of the APL value VAL, S(VAL), and $S(PMTC_i)$ to the difference between $S(SMTC_i)$ and $S(PMTC_i)$. 6 bit resolution is enough for this coefficient.

$$C(VAL) = 63 \times \frac{S(VAL) - S(PMTC_i)}{S(SMTC_i) - S(PMTC_i)}$$

The final extrapolation is:

$$output(V) = LUT1_i(V) + (LUT2_i(V) \times C(VAL))/64$$

It is possible to remove all the factors 64 and 63 in these expressions of $LUT2_i(V)$, V(VAL) and OUTPUT(V).

The primary Metacode LUTs are independent of the principle of the invention. Only, the other metacode LUTs are achieved from these primary metacode LUTs.

A possible implementation of the method of the invention is illustrated by Figure 2 as indicated below. The look-up tables LUT1, LUT2, LUT3 and LUT4 are stored in four memories 101, 102, 103 and 104. They can be included in an external memory (EPROM or FLASH) that can be read bit sequentially by a controller. The extrapolation is calculated by an extrapolation block 105. This block is connected to the dithering block 110 of figure 1. In normal operation, at the end of every frame, new $LUT1_i$ and $LUT2_i$ data have to be downloaded by the controller depending on the APL value that has been computed during the active part of the video signal based on the video data.

For each new input video input YI and APL value VAL, the memory 101, 102, 103 and 104 delivers to the block 105 respectively a new primary metacode, a new delta code, an new index of subset and a new extrapolation coefficient C and a new metacode data is computed by the block 105.

This method needs only $(16\times1024\times(12+8)+1024\times(6+4))\times3\times3=2.9\text{Mbit}$ for 3 modes instead of 108Mbit with the method implemented in Figure 1.

ANNEX

APL	Sustain pulses	Subset#	C
0	1100	15	63
1	1100	15	63
2	1100	15	63
3	1100	15	63
4	1100	15	63
5	1100	15	63
6	1100	15	63
7	1100	15	63
8	1100	15	63
9	1100	15	63
10	1100	15	63
11	1100	15	63
12	1100	15	63
13	1100	15	63
14	1100	15	63
15	1100	15	63
16	1100	15	63
17	1100	15	63
18	1100	15	63
19	1100	15	63
20	1100	15	63
21	1100	15	63
22	1100	15	63
23	1100	15	63
24	1100	15	63
25	1100	15	63
26	1100	15	63
27	1100	15	63
28	1100	15	63
29	1100	15	63
30	1100	15	63
31	1100	15	63
32	1100	15	63
33	1098	15	61
34	1097	15	61
35	1096	15	60
36	1095	15	60
37	1094	15	59
38	1093	15	59
39	1092	15	58
40	1091	15	57
41	1090	15	57
42	1089	15	56
43	1088	15	56
44	1086	15	55
45	1085	15	54
46	1084	15	54
47	1083	15	53
48	1082	15	52
49	1081	15	52
50	1080	15	51
51	1079	15	51
52	1078	15	50
53	1077	15	50
54	1076	15	49
55	1074	15	48
56	1073	15	47
57	1072	15	47
58	1071	15	46
59	1070	15	46
60	1069	15	45
61	1068	15	45
62	1067	15	44

APL	Sustain pulses	Subset#	C
63	1066	15	43
64	1065	15	43
65	1064	15	42
66	1063	15	42
67	1061	15	41
68	1060	15	40
69	1059	15	39
70	1058	15	39
71	1057	15	38
72	1056	15	38
73	1055	15	37
74	1054	15	37
75	1053	15	36
76	1052	15	36
77	1051	15	35
78	1050	15	34
79	1049	15	34
80	1047	15	33
81	1046	15	32
82	1045	15	32
83	1044	15	31
84	1043	15	30
85	1042	15	30
86	1041	15	29
87	1040	15	29
88	1039	15	28
89	1038	15	28
90	1037	15	27
91	1036	15	27
92	1035	15	26
93	1033	15	25
94	1032	15	24
95	1031	15	24
96	1030	15	23
97	1029	15	23
98	1028	15	22
99	1027	15	21
100	1026	15	21
101	1025	15	20
102	1024	15	20
103	1023	15	19
104	1022	15	19
105	1021	15	18
106	1019	15	17
107	1018	15	16
108	1017	15	16
109	1016	15	15
110	1015	15	15
111	1014	15	14
112	1013	15	14
113	1012	15	13
114	1011	15	12
115	1010	15	12
116	1009	15	11
117	1008	15	11
118	1007	15	10
119	1006	15	10
120	1004	15	9
121	1003	15	8
122	1002	15	7
123	1001	15	7
124	1000	15	6
125	999	15	6
126	998	15	5
127	997	15	5
128	996	15	4

APL	Sustain pulses	Subset#	C
129	995	15	3
130	994	15	3
131	993	15	2
132	992	15	2
133	991	15	1
134	990	15	1
135	**988**	**15**	**0**
136	987	14	63
137	986	14	62
138	985	14	61
139	984	14	61
140	983	14	60
141	982	14	59
142	981	14	59
143	980	14	58
144	979	14	57
145	978	14	57
146	977	14	56
147	976	14	56
148	975	14	55
149	974	14	54
150	972	14	53
151	971	14	52
152	970	14	52
153	969	14	51
154	968	14	50
155	967	14	50
156	966	14	49
157	965	14	49
158	964	14	48
159	963	14	47
160	962	14	47
161	961	14	46

APL	Sustain pulses	Subset#	C
162	960	14	45
163	959	14	45
164	958	14	44
165	957	14	43
166	956	14	43
167	954	14	42
168	953	14	41
169	952	14	40
170	951	14	40
171	950	14	39
172	949	14	38
173	948	14	38
174	947	14	37
175	946	14	36
176	945	14	36
177	944	14	35
178	943	14	35
179	942	14	34
180	941	14	33
181	940	14	33
182	939	14	32
183	938	14	31
184	937	14	31
185	935	14	29
186	934	14	29
187	933	14	28
188	932	14	28
189	931	14	27
190	930	14	26
191	929	14	26
192	928	14	25
193	927	14	24
194	926	14	24

APL	Sustain pulses	Subset#	C
195	925	14	23
196	924	14	22
197	923	14	22
198	922	14	21
199	921	14	21
200	920	14	20
201	919	14	19
202	918	14	19
203	917	14	18
204	915	14	17
205	914	14	16
206	913	14	15
207	912	14	15
208	911	14	14
209	910	14	14
210	909	14	13
211	908	14	12
212	907	14	12
213	906	14	11
214	905	14	10
215	904	14	10
216	903	14	9
217	902	14	8
218	901	14	8
219	900	14	7
220	899	14	7
221	898	14	6
222	897	14	5
223	896	14	5
224	895	14	4
225	893	14	3
226	892	14	2
227	891	14	1

APL	Sustain pulses	Subset#	C
228	890	14	1
229	889	14	0
230	**888**	**14**	**0**
231	887	13	63
232	886	13	62
233	885	13	61
234	884	13	60
235	883	13	60
236	882	13	59
237	881	13	58
238	880	13	58
239	879	13	57
240	878	13	56
241	877	13	55
242	876	13	55
243	875	13	54
244	874	13	53
245	873	13	53
246	872	13	52
247	871	13	51
248	870	13	50
249	869	13	50
250	867	13	48
251	866	13	48
252	865	13	47
253	864	13	46
254	863	13	46
255	862	13	45
256	861	13	44
257	860	13	43
258	859	13	43
259	858	13	42
260	857	13	41

APL	Sustain pulses	Subset#	C
261	856	13	41
262	855	13	40
263	854	13	39
264	853	13	38
265	852	13	38
266	851	13	37
267	850	13	36
268	849	13	36
269	848	13	35
270	847	13	34
271	846	13	33
272	845	13	33
273	844	13	32
274	843	13	31
275	842	13	31
276	841	13	30
277	840	13	29
278	839	13	29
279	838	13	28
280	837	13	27
281	835	13	26
282	834	13	25
283	833	13	24
284	832	13	24
285	831	13	23
286	830	13	22
287	829	13	21
288	828	13	21
289	827	13	20
290	826	13	19
291	825	13	19
292	824	13	18
293	823	13	17

APL	Sustain pulses	Subset#	C
294	822	13	16
295	821	13	16
296	820	13	15
297	819	13	14
298	818	13	14
299	817	13	13
300	816	13	12
301	815	13	12
302	814	13	11
303	813	13	10
304	812	13	9
305	811	13	9
306	810	13	8
307	809	13	7
308	808	13	7
309	807	13	6
310	806	13	5
311	805	13	4
312	804	13	4
313	803	13	3
314	802	13	2
315	801	13	2
316	800	13	1
317	799	13	0
318	**798**	**13**	**0**
319	797	12	63
320	796	12	62
321	795	12	61
322	794	12	60
323	793	12	59
324	792	12	59
325	790	12	57
326	789	12	56

APL	Sustain pulses	Subset#	C
327	788	12	55
328	787	12	55
329	786	12	54
330	785	12	53
331	784	12	52
332	783	12	51
333	782	12	51
334	781	12	50
335	780	12	49
336	779	12	48
337	778	12	48
338	777	12	47
339	776	12	46
340	775	12	45
341	774	12	44
342	773	12	44
343	772	12	43
344	771	12	42
345	770	12	41
346	769	12	40
347	768	12	40
348	767	12	39
349	766	12	38
350	765	12	37
351	764	12	37
352	763	12	36
353	762	12	35
354	761	12	34
355	760	12	33
356	759	12	33
357	758	12	32
358	757	12	31
359	756	12	30

APL	Sustain pulses	Subset#	C
360	755	12	29
361	754	12	29
362	753	12	28
363	752	12	27
364	751	12	26
365	750	12	25
366	749	12	25
367	748	12	24
368	747	12	23
369	746	12	22
370	745	12	22
371	744	12	21
372	743	12	20
373	742	12	19
374	741	12	18
375	740	12	18
376	739	12	17
377	738	12	16
378	737	12	15
379	736	12	14
380	735	12	14
381	734	12	13
382	733	12	12
383	732	12	11
384	731	12	11
385	730	12	10
386	729	12	9
387	728	12	8
388	727	12	7
389	726	12	7
390	725	12	6
391	724	12	5
392	723	12	4

APL	Sustain pulses	Subset#	C
393	722	12	3
394	721	12	3
395	720	12	2
396	719	12	1
397	718	12	0
398	**717**	**12**	**0**
399	716	11	63
400	715	11	62
401	714	11	61
402	713	11	60
403	712	11	59
404	711	11	58
405	710	11	57
406	709	11	56
407	708	11	56
408	707	11	55
409	706	11	54
410	705	11	53
411	704	11	52
412	703	11	51
413	702	11	50
414	701	11	49
415	700	11	49
416	699	11	48
417	698	11	47
418	697	11	46
419	696	11	45
420	695	11	44
421	694	11	43
422	693	11	42
423	692	11	42
424	691	11	41
425	690	11	40

APL	Sustain pulses	Subset#	C
426	689	11	39
427	688	11	38
428	687	11	37
429	686	11	36
430	685	11	35
431	684	11	35
432	684	11	35
433	683	11	34
434	682	11	33
435	681	11	32
436	680	11	31
437	679	11	30
438	678	11	29
439	677	11	28
440	676	11	28
441	675	11	27
442	674	11	26
443	673	11	25
444	672	11	24
445	671	11	23
446	670	11	22
447	669	11	21
448	668	11	21
449	667	11	20
450	666	11	19
451	665	11	18
452	664	11	17
453	663	11	16
454	662	11	15
455	661	11	14
456	660	11	14
457	659	11	13
458	658	11	12

APL	Sustain pulses	Subset#	C
459	657	11	11
460	656	11	10
461	655	11	9
462	654	11	8
463	653	11	7
464	652	11	7
465	651	11	6
466	650	11	5
467	649	11	4
468	648	11	3
469	647	11	2
470	646	11	1
471	645	11	0
472	644	11	0
473	**644**	**11**	**0**
474	643	10	63
475	642	10	62
476	641	10	61
477	640	10	60
478	639	10	59
479	638	10	58
480	637	10	57
481	636	10	56
482	635	10	55
483	634	10	54
484	633	10	53
485	632	10	52
486	631	10	51
487	630	10	50
488	629	10	49
489	628	10	48
490	627	10	47
491	626	10	46

APL	Sustain pulses	Subset#	C
492	625	10	45
493	624	10	44
494	623	10	43
495	622	10	42
496	621	10	41
497	620	10	40
498	619	10	39
499	618	10	38
500	617	10	37
501	617	10	37
502	616	10	36
503	615	10	35
504	614	10	34
505	613	10	33
506	612	10	32
507	611	10	31
508	610	10	30
509	609	10	29
510	608	10	28
511	607	10	27
512	606	10	26
513	605	10	25
514	604	10	24
515	603	10	23
516	602	10	22
517	601	10	21
518	600	10	20
519	599	10	19
520	598	10	18
521	597	10	17
522	596	10	16
523	596	10	16
524	595	10	15

APL	Sustain pulses	Subset#	C
525	594	10	14
526	593	10	13
527	592	10	12
528	591	10	11
529	590	10	10
530	589	10	9
531	588	10	8
532	587	10	7
533	586	10	6
534	585	10	5
535	584	10	4
536	583	10	3
537	582	10	2
538	581	10	1
539	580	10	0
540	**579**	**10**	**0**
541	578	9	63
542	578	9	63
543	577	9	61
544	576	9	60
545	575	9	59
546	574	9	58
547	573	9	57
548	572	9	56
549	571	9	55
550	570	9	54
551	569	9	53
552	568	9	52
553	567	9	51
554	566	9	49
555	565	9	48
556	564	9	47
557	563	9	46

APL	Sustain pulses	Subset#	C
558	562	9	45
559	562	9	45
560	561	9	44
561	560	9	43
562	559	9	42
563	558	9	41
564	557	9	40
565	556	9	39
566	555	9	38
567	554	9	36
568	553	9	35
569	552	9	34
570	551	9	33
571	550	9	32
572	549	9	31
573	548	9	30
574	548	9	30
575	547	9	29
576	546	9	28
577	545	9	27
578	544	9	26
579	543	9	24
580	542	9	23
581	541	9	22
582	540	9	21
583	539	9	20
584	538	9	19
585	537	9	18
586	536	9	17
587	535	9	16
588	535	9	16
589	534	9	15
590	533	9	14

APL	Sustain pulses	Subset#	C
591	532	9	13
592	531	9	11
593	530	9	10
594	529	9	9
595	528	9	8
596	527	9	7
597	526	9	6
598	525	9	5
599	524	9	4
600	524	9	4
601	523	9	3
602	522	9	2
603	521	9	1
604	**520**	**9**	**0**
605	519	8	63
606	518	8	61
607	517	8	60
608	516	8	59
609	515	8	58
610	514	8	56
611	513	8	55
612	513	8	55
613	512	8	54
614	511	8	53
615	510	8	52
616	509	8	50
617	508	8	49
618	507	8	48
619	506	8	47
620	505	8	46
621	504	8	44
622	503	8	43
623	502	8	42

APL	Sustain pulses	Subset#	C
624	502	8	42
625	501	8	41
626	500	8	39
627	499	8	38
628	498	8	37
629	497	8	36
630	496	8	35
631	495	8	33
632	494	8	32
633	493	8	31
634	493	8	31
635	492	8	30
636	491	8	29
637	490	8	27
638	489	8	26
639	488	8	25
640	487	8	24
641	486	8	23
642	485	8	21
643	484	8	20
644	484	8	20
645	483	8	19
646	482	8	18
647	481	8	16
648	480	8	15
649	479	8	14
650	478	8	13
651	477	8	12
652	476	8	10
653	475	8	9
654	475	8	9
655	474	8	8
656	473	8	7

APL	Sustain pulses	Subset#	C
657	472	8	6
658	471	8	4
659	470	8	3
660	469	8	2
661	468	8	1
662	467	8	0
663	**467**	**8**	**0**
664	466	7	63
665	465	7	61
666	464	7	60
667	463	7	58
668	462	7	57
669	461	7	56
670	460	7	54
671	459	7	53
672	459	7	53
673	458	7	52
674	457	7	50
675	456	7	49
676	455	7	47
677	454	7	46
678	453	7	45
679	452	7	43
680	451	7	42
681	451	7	42
682.	450	7	41
683	449	7	39
684	448	7	38
685	447	7	36
686	446	7	35
687	445	7	34
688	444	7	32
689	444	7	32

APL	Sustain pulses	Subset#	C
690	443	7	31
691	442	7	30
692	441	7	28
693	440	7	27
694	439	7	26
695	438	7	24
696	437	7	23
697	437	7	23
698	436	7	21
699	435	7	20
700	434	7	19
701	433	7	17
702	432	7	16
703	431	7	15
704	430	7	13
705	430	7	13
706	429	7	12
707	428	7	10
708	427	7	9
709	426	7	8
710	425	7	6
711	424	7	5
712	424	7	5
713	423	7	4
714	422	7	2
715	421	7	1
716	**420**	**7**	**0**
717	419	6	63
718	418	6	61
719	417	6	59
720	417	6	59
721	416	6	58
722	415	6	56

APL	Sustain pulses	Subset#	C
723	414	6	55
724	413	6	53
725	412	6	52
726	411	6	50
727	411	6	50
728	410	6	49
729	409	6	47
730	408	6	46
731	407	6	44
732	406	6	43
733	405	6	41
734	405	6	41
735	404	6	39
736	403	6	38
737	402	6	36
738	401	6	35
739	400	6	33
740	400	6	33
741	399	6	32
742	398	6	30
743	397	6	29
744	396	6	27
745	395	6	26
746	394	6	24
747	394	6	24
748	393	6	23
749	392	6	21
750	391	6	19
751	390	6	18
752	389	6	16
753	389	6	16
754	388	6	15
755	387	6	13

APL	Sustain pulses	Subset#	C
756	386	6	12
757	385	6	10
758	384	6	9
759	384	6	9
760	383	6	7
761	382	6	6
762	381	6	4
763	380	6	3
764	379	6	1
765	379	6	1
766	**378**	**6**	**0**
767	377	5	63
768	376	5	61
769	375	5	59
770	374	5	57
771	374	5	57
772	373	5	56
773	372	5	54
774	371	5	52
775	370	5	51
776	369	5	49
777	369	5	49
778	368	5	47
779	367	5	45
780	366	5	44
781	365	5	42
782	364	5	40
783	364	5	40
784	363	5	39
785	362	5	37
786	361	5	35
787	360	5	34
788	360	5	34

APL	Sustain pulses	Subset#	C
789	359	5	32
790	358	5	30
791	357	5	28
792	356	5	27
793	355	5	25
794	355	5	25
795	354	5	23
796	353	5	22
797	352	5	20
798	351	5	18
799	351	5	18
800	350	5	17
801	349	5	15
802	348	5	13
803	347	5	11
804	347	5	11
805	346	5	10
806	345	5	8
807	344	5	6
808	343	5	5
809	343	5	5
810	342	5	3
811	341	5	1
812	**340**	**5**	**0**
813	339	4	63
814	339	4	63
815	338	4	61
816	337	4	59
817	336	4	57
818	335	4	55
819	335	4	55
820	334	4	53
821	333	4	51

APL	Sustain pulses	Subset#	C
822	332	4	49
823	331	4	47
824	331	4	47
825	330	4	45
826	329	4	43
827	328	4	42
828	327	4	40
829	327	4	40
830	326	4	38
831	325	4	36
832	324	4	34
833	324	4	34
834	323	4	32
835	322	4	30
836	321	4	28
837	320	4	26
838	320	4	26
839	319	4	24
840	318	4	22
841	317	4	21
842	316	4	19
843	316	4	19
844	315	4	17
845	314	4	15
846	313	4	13
847	313	4	13
848	312	4	11
849	311	4	9
850	310	4	7
851	310	4	7
852	309	4	5
853	308	4	3
854	307	4	1

APL	Sustain pulses	Subset#	C
855	306	4	0
856	**306**	**4**	**0**
857	305	3	63
858	304	3	60
859	303	3	58
860	303	3	58
861	302	3	56
862	301	3	54
863	300	3	52
864	300	3	52
865	299	3	50
866	298	3	48
867	297	3	46
868	297	3	46
869	296	3	44
870	295	3	42
871	294	3	39
872	294	3	39
873	293	3	37
874	292	3	35
875	291	3	33
876	291	3	33
877	290	3	31
878	289	3	29
879	288	3	27
880	288	3	27
881	287	3	25
882	286	3	23
883	285	3	21
884	285	3	21
885	284	3	18
886	283	3	16
887	283	3	16

APL	Sustain pulses	Subset#	C
888	282	3	14
889	281	3	12
890	280	3	10
891	280	3	10
892	279	3	8
893	278	3	6
894	277	3	4
895	277	3	4
896	276	3	2
897	275	3	0
898	**275**	**3**	**0**
899	274	2	63
900	273	2	60
901	272	2	58
902	272	2	58
903	271	2	56
904	270	2	53
905	270	2	53
906	269	2	51
907	268	2	49
908	267	2	46
909	267	2	46
910	266	2	44
911	265	2	42
912	265	2	42
913	264	2	39
914	263	2	37
915	262	2	35
916	262	2	35
917	261	2	32
918	260	2	30
919	260	2	30
920	259	2	28

APL	Sustain pulses	Subset#	C
921	258	2	25
922	258	2	25
923	257	2	23
924	256	2	21
925	256	2	21
926	255	2	18
927	254	2	16
928	253	2	14
929	253	2	14
930	252	2	11
931	251	2	9
932	251	2	9
933	250	2	7
934	249	2	4
935	249	2	4
936	248	2	2
937	247	2	0
938	**247**	**2**	**0**
939	246	1	63
940	245	1	60
941	245	1	60
942	244	1	57
943	243	1	55
944	243	1	55
945	242	1	52
946	241	1	49
947	241	1	49
948	240	1	47
949	239	1	44
950	239	1	44
951	238	1	42
952	238	1	42
953	237	1	39

APL	Sustain pulses	Subset#	C
954	236	1	36
955	236	1	36
956	235	1	34
957	234	1	31
958	234	1	31
959	233	1	28
960	232	1	26
961	232	1	26
962	231	1	23
963	231	1	23
964	230	1	21
965	229	1	18
966	229	1	18
967	228	1	15
968	228	1	15
969	227	1	13
970	226	1	10
971	226	1	10
972	225	1	7
973	224	1	5
974	224	1	5
975	223	1	2
976	223	1	2
977	222	1	0
978	**222**	**1**	**0**
979	221	0	63
980	220	0	60
981	220	0	60
982	219	0	57
983	219	0	57
984	218	0	54
985	217	0	51
986	217	0	51

APL	Sustain pulses	Subset#	C
987	216	0	48
988	216	0	48
989	215	0	45
990	215	0	45
991	214	0	42
992	214	0	42
993	213	0	39
994	212	0	36
995	212	0	36
996	211	0	33
997	211	0	33
998	210	0	30
999	210	0	30
1000	209	0	27
1001	209	0	27
1002	208	0	24
1003	208	0	24
1004	207	0	21
1005	207	0	21
1006	206	0	18
1007	206	0	18
1008	205	0	15
1009	205	0	15
1010	204	0	12
1011	204	0	12
1012	204	0	12
1013	203	0	9
1014	203	0	9
1015	202	0	6
1016	202	0	6
1017	201	0	3
1018	201	0	3
1019	201	0	3

APL	Sustain pulses	Subset#	C
1020	200	0	0
1021	200	0	0
1022	200	0	0
1023	**200**	**0**	**0**

CLAIMS

1. Method for generating a look-up table data for an input video data (YI) and for a given value (VAL) of a parameter (APL) among N different values, characterized in that said look-up table data is generated from two look-up tables defined for the two bound values of said parameter (APL) and an extrapolation coefficient, said look-up tables comprising an output data for each possible input video data (YI).

2. Method according to claim 1, characterized in that said look-up table data can be approximated by a piecewise linear function of a variable (S(VAL)) depending on the given value and that it comprises the following steps:

- dividing the set of N values into P subsets of consecutive values, each piece of the piecewise linear function being in a different subset;
- defining a look-up table for the two bound values of each subset i, called primary look-up table ($PMTC_i$) and secondary look-up table ($SMTC_i$) respectively, each of said primary and secondary look-up tables comprising an output data (PMTC, SMTC) for each possible input video data (YI),
- defining, for each subset i, a delta look-up table corresponding to the difference between the secondary look-up table ($SMTC_i$) and the primary look-up table ($PMTC_i$) related to the subset i,
- defining, for each one of said N values, an extrapolation coefficient (C(VAL)) in accordance with the value (S(VAL)) of a variable S for the given value (VAL) and the values ($S(PMTC_i)$,$S(SMTC_i)$) of the variable S for the two bound values of the subset i comprising the given value; and
- computing the look-up table data for said input video data (YI) and for the given value (VAL) in accordance with the extrapolation coefficient (C(VAL)) defined for the given value (VAL) and the output data of the primary look-up table ($PMTC_i$) and the delta look-up table for said for said input video data (YI).

3. Method according to claim 2, characterized in that the look-up table data is a Metacode look-up table data, the parameter is an average power level and the variable (S(VAL)) is a number of sustain pulses corresponding to the given value (VAL) of the parameter.

4. Method according to claim 3, characterized in that the bound level related to the primary look-up table ($PMTC_i$) of a subset of average power level values is the highest average power level value of the subset and the bound level related to the secondary look-up table ($SMTC_i$) of a subset of average power level values is the lowest average power level value of the subset.

5. Method according to one of the claims 2 to 4, characterized in that the ratio between the value ($S(PMTC_i)$) of the variable for one bound value in the subset i and the value ($S(PMTC_{i+1})$) of the variable for the same bound value in the subset i+1 equals to a fixed parameter α.

6. Method according to the claim 5, characterized in that the parameter α is defined as followed : $\alpha = \sqrt[N]{\frac{S_{MAX}}{S_{MIN}}}$

where S_{MAX} is the value of the variable (S) for a peak white image and S_{MIN} is the value of the variable (S) for a full white image.

7. Method according to one of the claims 2 to 6, characterized in that the extrapolation coefficient (C(VAL)) is proportional to:

$$\frac{S(VAL) - S(PMTC_i)}{S(SMTC_i) - S(PMTC_i)}$$

where - $S(PMTC_i)$ is the value of the variable for the highest bound value of the subset i;

- $S(SMTC_i)$ is the value of the variable for the lowest bound value of the subset i; and

- S(VAL) is the value of the variable for the given value.

8. Method according to one of the claims 2 to 7, characterized in that the computed look-up table data equals to the sum of the output data of the primary look-up table ($PMTC_i$) and the output data of the delta look-up table ($PMTC_i$) for said input video data (YI) and the given value (VAL) weighted by the extrapolation coefficient for the given value (VAL).

9. Device for generating a look-up table data for an input video data (YI) and for a given value (VAL) of a parameter (APL) among N different values, said output data being approximated by a piecewise linear function of a variable (S(VAL)) depending on the given value, the set of N values being divided into P subsets of consecutive values, each piece of the piecewise linear function being in a different subset, characterized in that it comprises:

- a first memory (101) for storing, for each subset i, a primary look-up table ($PMTC_i$) associated to a bound value of the subset i and comprising an output data (PMTC) for each possible input video data (YI),

- a second memory (102) for storing, for each subset i, a delta look-up table corresponding to the difference between a secondary look-up table ($SMTC_i$) and the primary look-up table ($PMTC_i$) related to the subset i, the secondary look-up table ($SMTC_i$) being associated to the other bound value of the subset i and comprising an output data (SMTC) for each possible input video data (YI),,

- a third memory (103) for storing, for each of said N values, an index indicating which primary look-up table in the first memory (101) and which delta look-up table in the second memory (102) have to be used for extrapolation,

- a fourth memory (104) for storing an extrapolation coefficient (C) for each one of said N values, the extrapolation coefficient (C(VAL)) associated to a given value being defined in accordance with the value (S(VAL)) of a variable S for said given value (VAL) and the values ($S(PMTC_i)$,$S(SMTC_i)$) of the variable S for the two bound values of the subset i comprising said given value; and

- a computing block (105) for generating a look-up table data for said input video data (YI) and for the given value (VAL) in accordance with the extrapolation coefficient (C(VAL)) defined for the given value (VAL) and the output data of the primary look-up table ($PMTC_i$) and the delta look-up table for said input video data (YI).

10. Device according to claim 9, characterized in that the parameter is an average power level and the variable (S(VAL)) is a number of sustain pulses corresponding to the given value (VAL) of the parameter

and that it generates a Metacode look-up table data for each average power level value.

11. Device according to claim 10, characterized in that the bound level related to the primary look-up table ($PMTC_i$) of a subset of average power level values is the highest average power level value of the subset and the bound level related to the secondary look-up table ($SMTC_i$) of a subset of average power level values is the lowest average power level value of the subset.

12. Device according to one of the claims 9 to 11, characterized in that the ratio between the value ($S(PMTC_i)$) of the variable for one bound value in the subset i and the value ($S(PMTC_{i+1})$) of the variable for the same bound value in the subset i+1 equals to a fixed parameter α.

13. Device according to the claim 12, characterized in that the parameter α is defined as followed : $\alpha = \sqrt[N]{\frac{S_{MAX}}{S_{MIN}}}$

where S_{MAX} is the value of the variable (S) for a peak white image and S_{MIN} is the value of the variable (S) for a full white image.

14. Device according to one of the claims 9 to 13, characterized in that the extrapolation coefficient (C(VAL)) is proportional to :

$$\frac{S(VAL)-S(PMTC_i)}{S(SMTC_i)-S(PMTC_i)}$$

where - $S(PMTC_i)$ is the value of the variable for the highest bound value of the subset i;

- $S(SMTC_i)$ is the value of the variable for the lowest bound value of the subset i; and

- $S(VAL)$ is the value of the variable for the given value.

15. Device according to one of the claims 9 to 14, characterized in that the look-up table data computed by the computing block (105) equals to the sum of the output data of the primary look-up table ($PMTC_i$) and the output data of the delta look-up table ($PMTC_i$) for said input video data (YI) the given value (VAL) weighted by the extrapolation coefficient for the given value (VAL).

ABSTRACT

METHOD AND APPARATUS FOR GENERATING LOOK-UP TABLE DATA IN THE VIDEO PICTURE FIELD

The present invention is particularly useful in the field of plasma display panels (PDPs) or other display devices wherein each video level is represented by a combination of bits according to a specific coding. In this case, when the algorithms used to improve picture quality are based on data stored in memories such as look-up tables (LUTs), the size of such tables may be quite huge. To improve picture quality in PDPs, an algorithm using metacode LUTs has been developed, using data stored in look-up tables. The invention proposes a way to reduce the amount of look-up tables needed for implementing metacodes. According to the invention, only some look-up tables of low size are stored and the other ones are achieved by extrapolation.

FIG.2

1/1

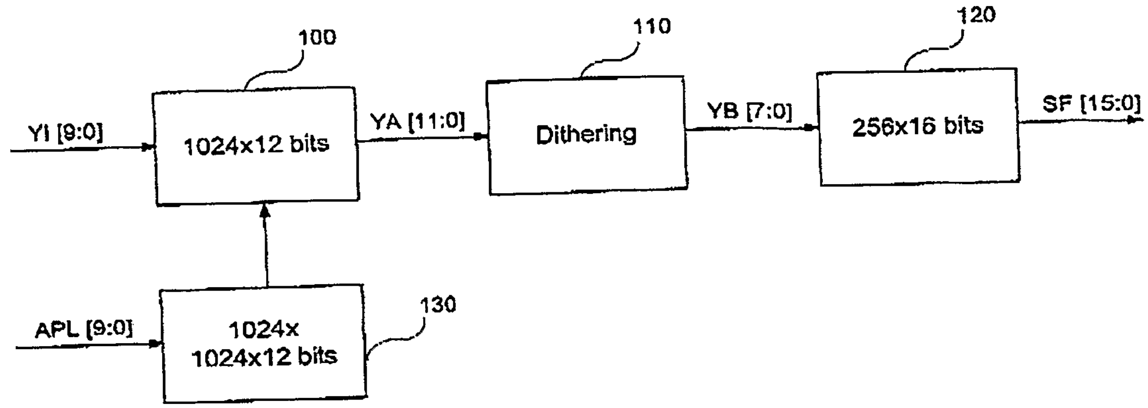

FIG.1 (Prior art)

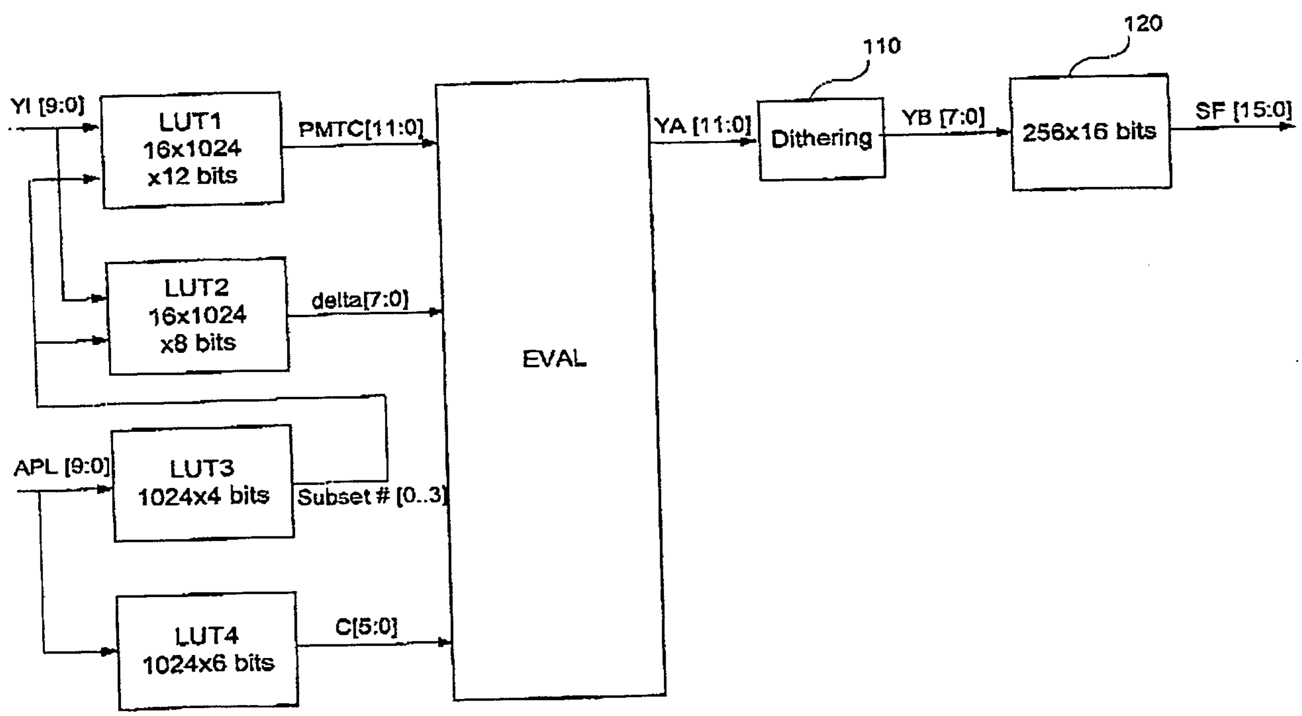

FIG.2